güralp

GPS Receiver conversion

Technical Procedure

Document No. PRC-GPS-0001

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Table of Contents

1 Preliminary Notes

1.1 Proprietary Notice

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1.2 Warnings, Cautions and Notes

Warnings, cautions and notes are displayed and defined as follows:

Warning: A black cross indicates a chance of injury or death if the warning is not heeded.

Caution: A yellow triangle indicates a chance of damage to or failure of the equipment if the caution is not heeded.

Caution - ESD: The circuit boards contained within the instrument include components which can be damaged by electrostatic discharge. Always work on a properly grounded dissipative surface and wear a suitable grounded wristband. Ground yourself by touching an earthed conductor before handling any of the circuit boards.

Note: A blue circle indicates indicates a procedural or advisory note.

1.3 Manuals and Software

All manuals and software referred to in this document are available from the Güralp Systems website: https://www.guralp.com/ unless otherwise stated.

2   Introduction

2.1   Important notice

The information in this document is believe to be correct at the time of writing. The information in our possession, however, is currently changing daily. Please look on our web-site to ensure that you have the latest version of this document before commencing any work. The latest version will be posted at:

https://www.guralp.com/documents/PRC-GPS-0001.pdf

2.2   Overview

Güralp GPS receivers have historically used a number of different chip-sets from different manufacturers. The original design of the US' Navstar GPS system had a fundamental flaw known as the Week-Number Roll-Over problem or WRNO (see section 4.1 on page 12) which means that some of these chip-sets will cease to function properly after certain dates.

In particular, we have been informed that two chip-sets will fail in the near future:

- the Trimble Lassen SQ®, used between 2003 and 2010, will cease to operate correctly on the 28th of July, 2019; and

- the Trimble Lassed iQ®, used between 2010 and February 2015, will cease to operate correctly on the 29th of May, 2021.

GPS receivers supplied since February 2015, identifiable by a serial number beginning G3…, use chip-sets manufactured by u-blox® and will not be affected by the WNRO.

This document explains how to replace a PCB assembly within the GPS receiver in order to convert Trimble-based units to use the u-blox chip-set.

> ⚠ **Caution:** The digitiser with which the upgraded receiver is being used must be upgraded to run the latest firmware if it is not already running it. Please refer to our web page at www.guralp.com/support/firmware for the latest information.

2.3   Scope

These instructions apply only to GPS receivers containing Trimble Lassen SQ®, or Trimble Lassen iQ®, chip-sets. These can be identified either by visual inspection or by analysis of their NMEA output. For information about identification techniques, please see section 4.2 on page 13.

2.4   Prerequisites

2.4.1 Tools and facilities

The following tools and facilities are required:

- anti-static workstation and wrist-band   ;

- small strap-wrench   ;

- selection of common screw-drivers and hex wrenches   ; and
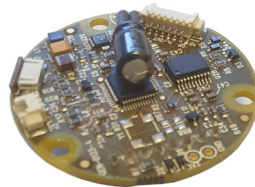
- M3 nut-driver or 5 mm spanner   .

2.4.2 Materials

The following materials are required:

- Replacement PCB assembly   ; and

- Replacement pre-greased O-ring seal   .

> **Caution - ESD:** The replacement PCB assembly includes components which can be damaged by electrostatic discharge. Always work on a properly grounded dissipative surface and wear a suitable grounded wristband. Ground yourself by touching an earthed conductor before handling the assembly.

3   The procedure

Proceed according to the directions below. If you encounter problems, please do not proceed: stop and contact Güralp support (via an email to support@guralp.com). It will normally be very helpful if you can include photographs illustrating the problem you have experienced.

1. Remove the cap of the GPS assembly by unscrewing it:
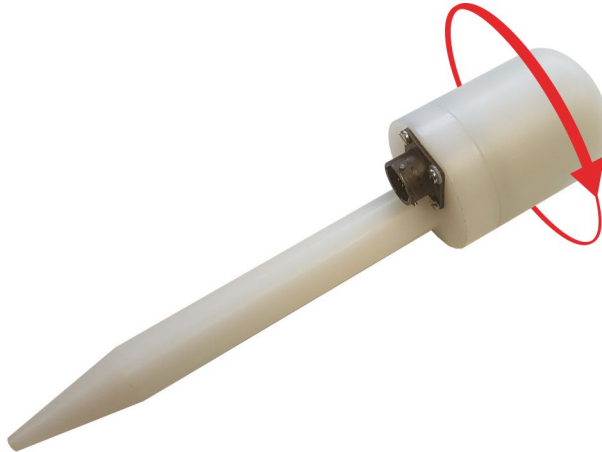
If the cap is difficult to remove, try bracing the spike and connector against the edge of the bench:
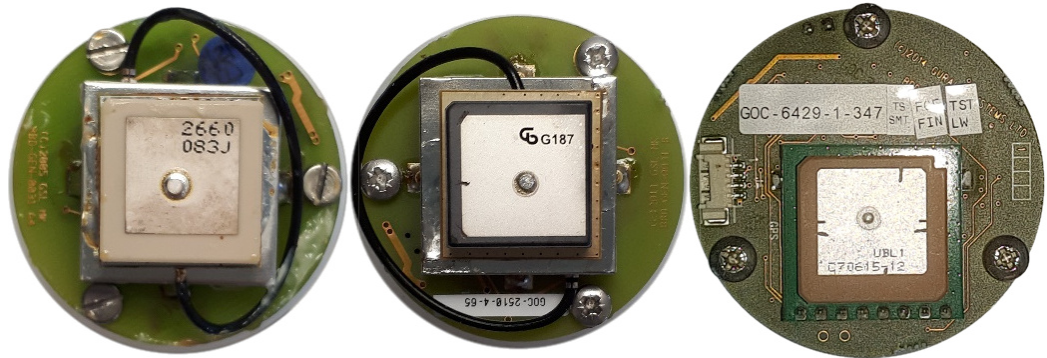

Rubber gloves may be helpful to give you a better grip.

In extreme cases, use a strap-wrench:

2. Check that the PCB assembly contains either a Trimble Lassen SQ®, or Trimble Lassen iQ® by comparing it with the images below:

The three receivers shown contain, from left to right,

1. Trimble Lassen SQ® (cream/ceramic-coloured module with silver top)

2. Trimble Lassen iQ® (black module with silver top)

3. u-blox PAM 7Q (brown module with silver top)

> ⊘ **Note:** Only proceed if you have one of the two Trimble Lassen®-based PCBs. If you have a receiver based on the u-blox chip-set, as shown on the right above, you will not be affected by the WRNO and you do not need to replace the PCB assembly.
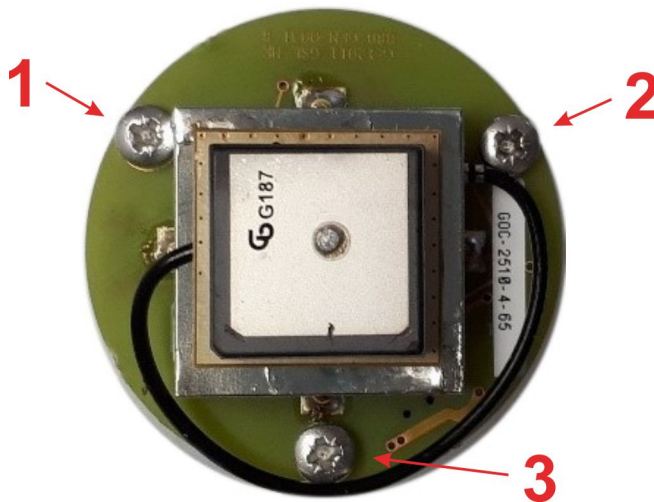
3. Identify the 6 way connector on the middle circuit board:

Disconnect it by grasping the connector on each side and pulling:

4. Using an appropriate tool, remove the three screws and washers holding the top circuit board in place. Retain these components for re-fitting.


> ❗ **Note:** The actual fasteners used may be different from those shown. You may encounter PZ2 cross-head screws, 5 mm flat-head screws, M3 hex-socket screws or another fastener. This makes no difference to the operation of the unit.

5. Remove the top circuit board assembly by lifting it upwards and to one side:
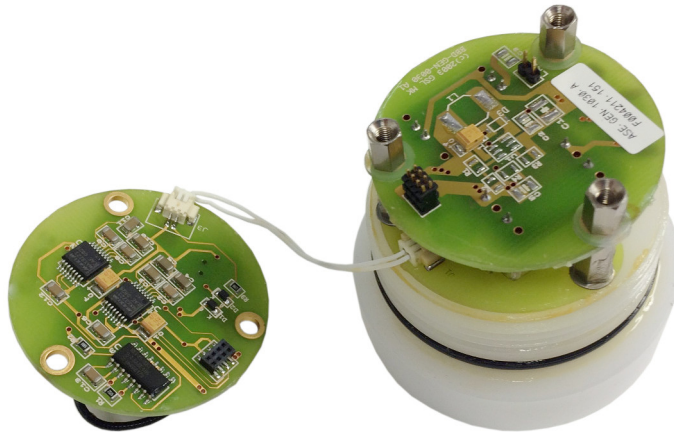
6. Using a 5 mm nut-spinner or spanner, unscrew and remove the three short stand-off pillars and set them aside.

7. Remove the middle circuit board assembly by lifting it upwards. Set it aside.
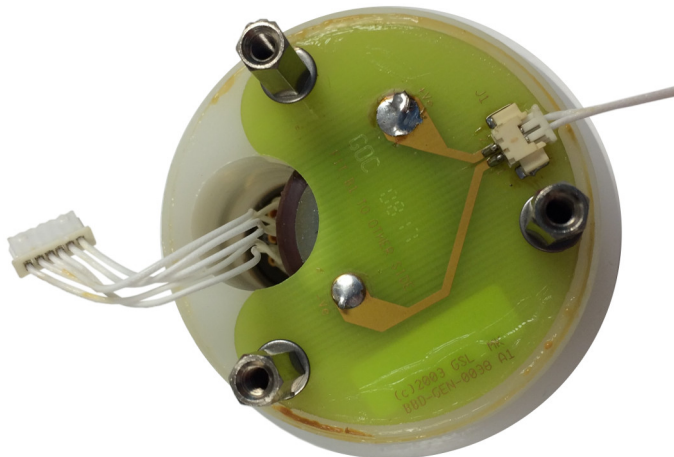
8. Using a 5 mm nut-spinner or spanner, unscrew and remove the three long stand-off pillars. Retain these components for re-fitting.

9. Remove the bottom circuit board assembly by lifting it upwards. Set it aside.

10. Using a 5 mm nut-spinner or spanner, re-fit the long stand-off pillars to the receiver body, placing a metal washer between the bottom of each stand-off pillar and the body.

Stand-off pillars
refitted
with washers below
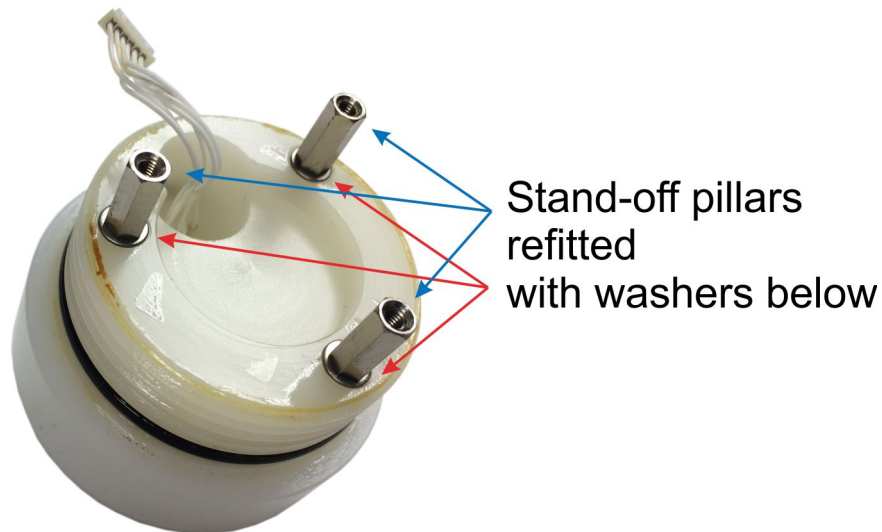
⚠️ **Caution:** Tighten the stand-off pillars only until they are secure. Over-tightening may result in the threads being stripped. If this happens, you can use a little super glue or a little epoxy resin to repair the thread and hold the stand-off in place.

11. Using an anti-static wrist band and an appropriate screw-driver, fit the new U-blox PAM-7 circuit board assembly onto the stand-off pillars using the three screws removed previously. Do not over-tighten. Take care to orientate the board relative to the base as shown in the photograph below.
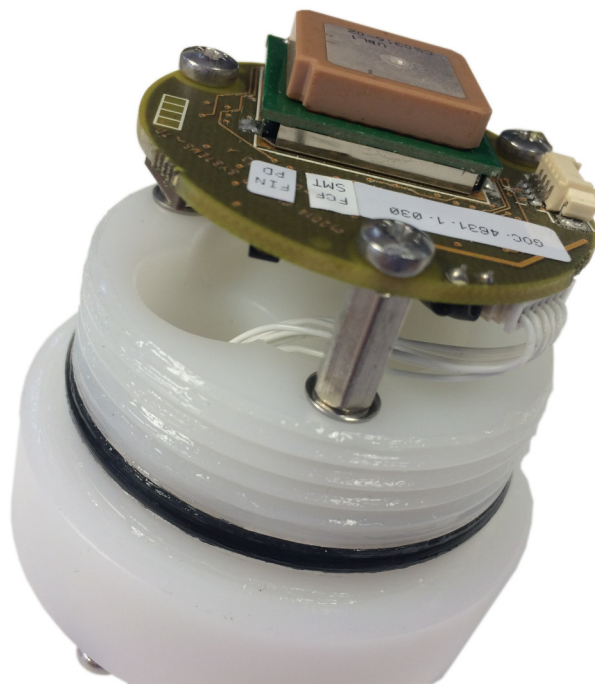
12. Connect the 6 way connector to the PAM-7 circuit board.

13. Remove the old O-ring from the receiver body and discard it. Check the groove where it lay for any grit, dust or contamination and clean if necessary.

14. Check the new O-ring seal for any grit, ensure that the grease is evenly distributed and then fit the new O-ring to the receiver body

15. Finally, re-fit the top cover to the receiver body, taking care not to cross the threads.

> ⚠️ **Caution:** Do not use tools. Hand tighten only.

16. The GPS/GNSS receiver is now ready to be tested.

> ⚠️ **Caution:** The digitiser with which the upgraded receiver is being used must be upgraded to run the latest firmware if it is not already running it. Please refer to our web page at www.guralp.com/support/firmware for the latest information.

4   Appendices

4.1   Background information

> **Note:** The use of the term "GPS" in this document refers to the US-operated NavStar/GPS Global Navigation Satellite System (GNSS). Other GNSSs, such as GLONASS, Galileo or BeiDou, are not affected by the problem described in this article.

Although the GPS system can be used to determine the date and time with extreme accuracy, the GPS satellite constellation does not actually transmit the full date to GPS receivers. Instead, a ten-bit value called "Week Number" is transmitted every thirty seconds, as part of each subframe of the "Navigation Message". It is the responsibility of the receiver to calculate the date from this value. (The time within the week is transmitted as the number of seconds since midnight on Saturday/Sunday.)

GPS week zero started at the beginning of 00:00:00 UTC on January the 6th, 1980. A ten-bit field can only hold 1024 different values so this system was never going to last forever. Indeed, week 1023 was first reached on August the 15th, 1999. The following week, the GPS satellites populated the Week Number field with a value of zero. (Because GPS time does not recognise leap-seconds, the "roll-over" from week 1023 to week zero actually took place at the end of 23:59:47 UTC on August the 21st.)

The second roll-over occurred on April the 6th, 2019, when the Week Number field changed again from 1023 to zero.

Manufacturers of GPS receiver chip-sets must each choose a way to determine the correct date from the GPS Week Number. If the chosen method fails, the announced date will be 1024 weeks - about 19.7 years - in the past or, possibly, the future. One common method uses the date of the version of the firmware as a hint, which works well if the receiver is new or regularly updated. A significant problem with this method arises when the firmware is not updated: the receiver can start producing incorrect dates at the 1024-week anniversary of the firmware date. This means that problems can actually appear at any time, irrespective of the actual roll-over date.

The receivers use the calculated date, along with the information about which satellites will be visible at any particular time and date (the GPS almanac), to calculate which satellites should be in view so, if the date is miscalculated, the performance of the receiver may also decrease dramatically.

4.2   Receiver identification

Güralp systems have used several different types of chip-set in their GPS receivers. These fall into three categories:

- Garmin and Motorola chip-sets: These receivers are no longer supported.

- Trimble Lassen chip-sets: These receivers need to be upgraded as described in this document.

- U-blox chip-sets: These receivers are not affected by the WNRO problem.

The photos below shows a Garmin-based receiver on the left. This unit has a ridged cap. The receivers in the middle are Motorola-based. While not as large as the Garmin-based units, they are significantly larger than modern receivers. A CD (120 mm diameter) is shown to illustrate the scale. The receivers shown on the right contain either Trimble Lassen or U-blox chipsets. They are 59 mm in diameter.

If you have one of the more modern, smaller (59 mm Ø) receivers, there are a number of ways to determine which chip-set is used.

4.2.1 Serial numbers

The serial number of the receiver is engraved on a white plate screwed to the base of the receiver.

If your serial number begins `G3…`, it has a u-blox chip-set and does not need to be upgraded.

If your serial number begins `G1…` or `G2…`, it may have a Trimble chip-set (either iQ or SQ) and may need to be replaced. Another identification technique is required to distinguish in this case.

4.2.2 Visual inspection

The top of the GPS receiver can be unscrewed to reveal the antenna, processor and associated electronics. This is easiest if you brace the receiver's spike and connector against the top edge of a desk. A rubber glove may also help.

Compare your unit to the photographs below, paying particular attention to the antenna, which is the uppermost component and is identified by its silver top:
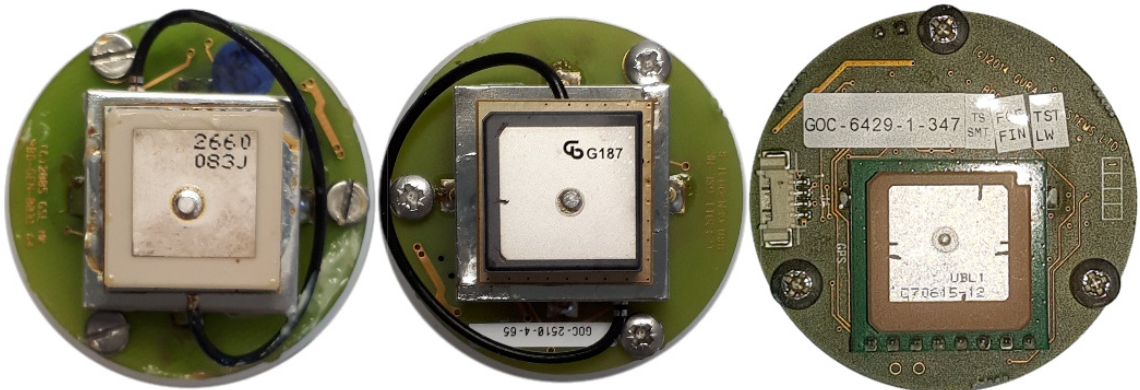
- Left: Lassen SQ chip-set. The antenna has a cream-coloured casing
- Centre: Lassen iQ chip-set. The antenna has a black casing
- Right: u-blox chip-set. The antenna has a brown casing

4.2.3 NMEA analysis

The situation regarding NMEA analysis is changing frequently as we receive new information from our suppliers. Please consult www.guralp.com/howtos/gps-wnro for the latest information.

5   Revision History

C	2019-05-15	Added an initial caution about the need for a digitiser firmware upgrade. Upgraded final note on same subject to caution.
B	2019-04-10	Removed current consumption information, which has not proved a reliable method for discrimination between models.
A	2019-04-09	Initial release